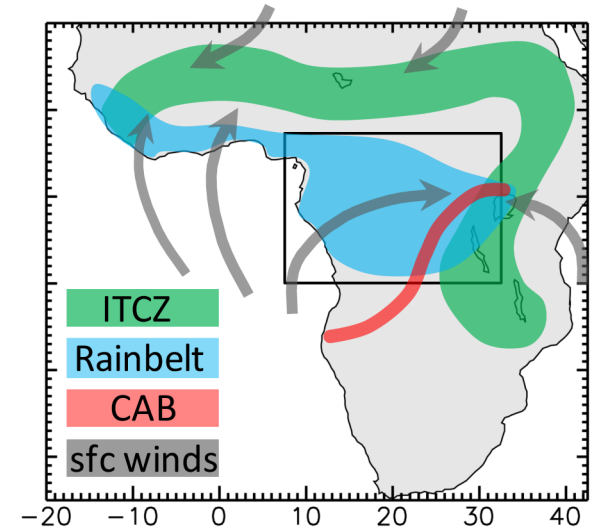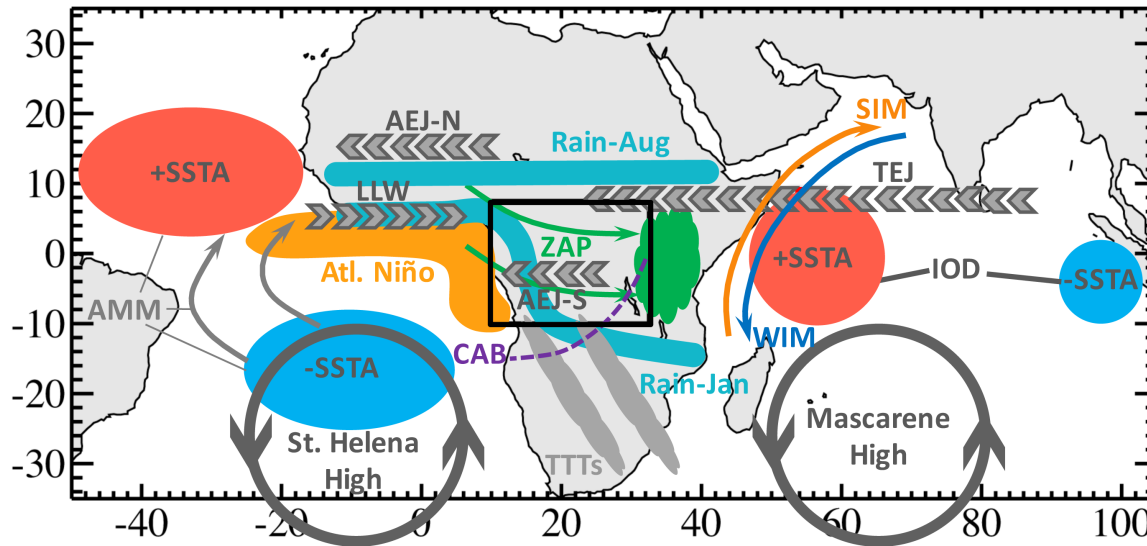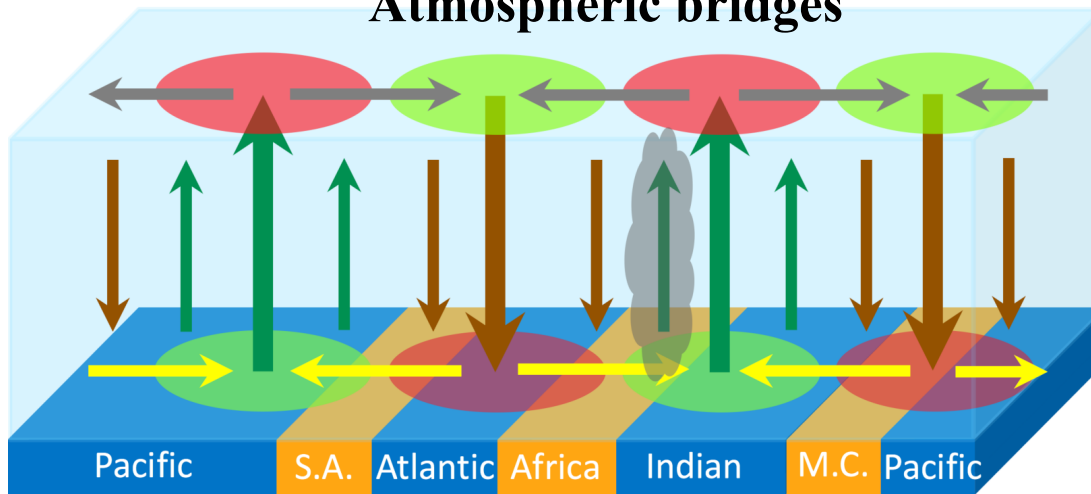# Precipitation characteristics in tropical Africa using satellite and in situ observations

Amin Dezfuli, Charles Ichoku, George Huffman, Karen Mohr and TAHMO team
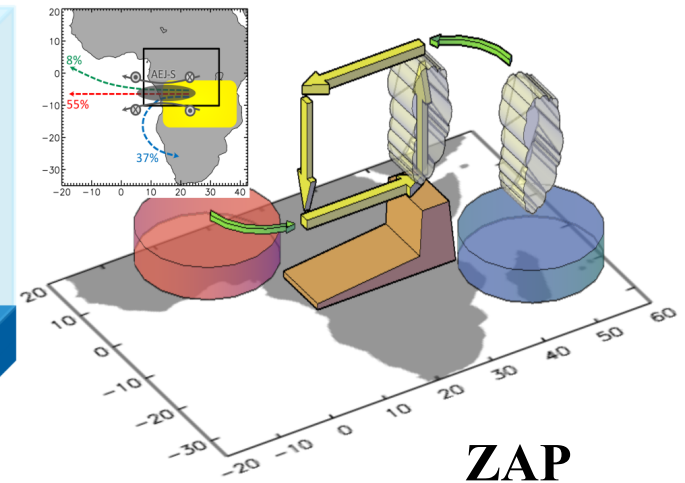
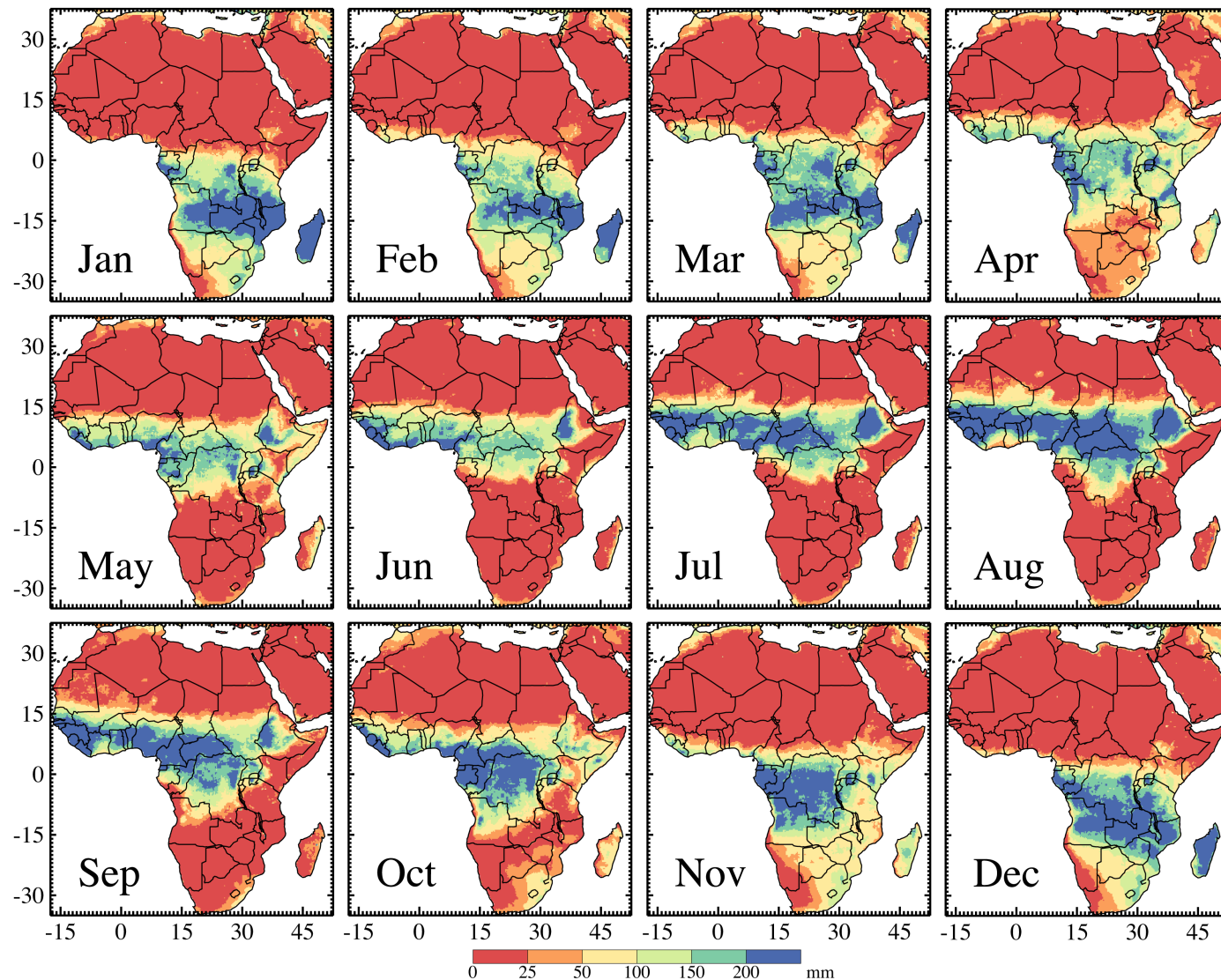# African rainfall: global & regional implications
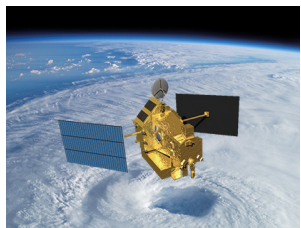

Atmospheric bridges

ZAP

(Dezfuli, 2017)

Annual cycle of precipitation

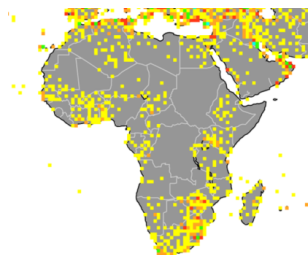# Precipitation data sets

- **TMPA**: TRMM Multi-Satellite Precipitation Analysis, 3B42 v7

- **IMERG**: Integrated Multi-satellitE Retrievals for GPM, V04A

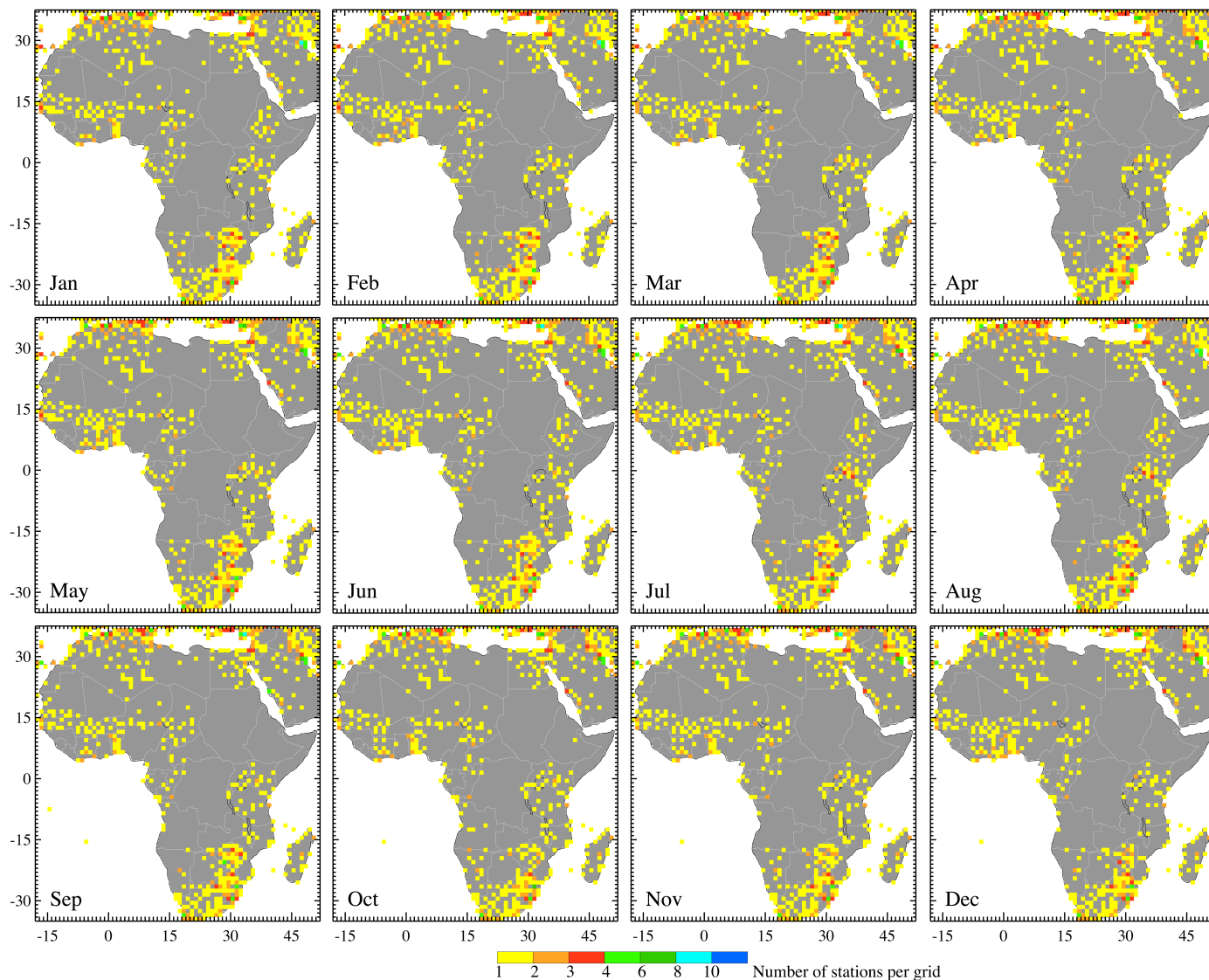- **TAHMO**: Trans-African Hydro-Meteorological Observatory

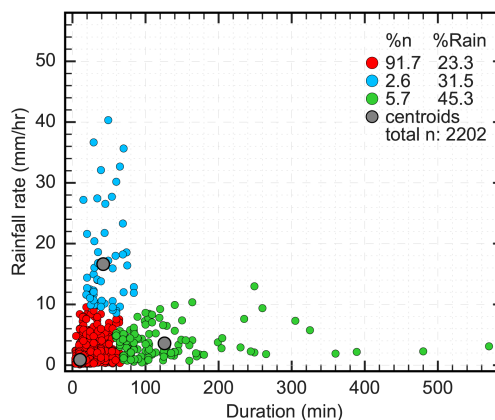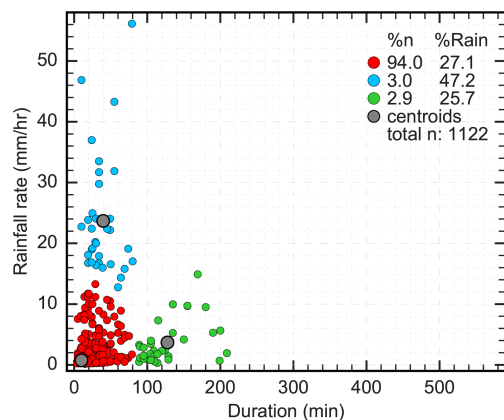- **GPCC**: Global Precipitation Climatology Centre, 1st Guess Daily
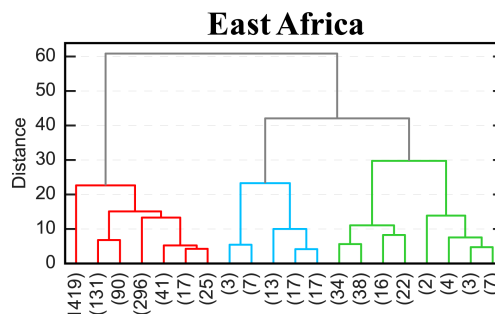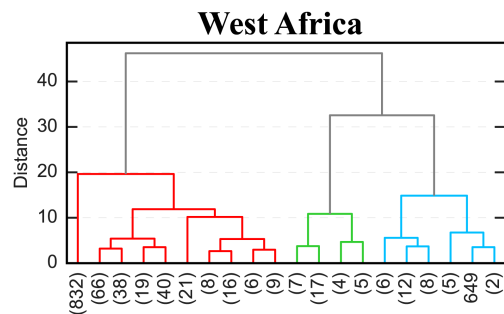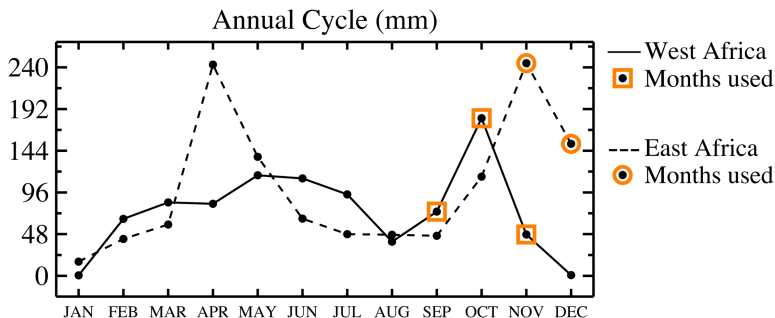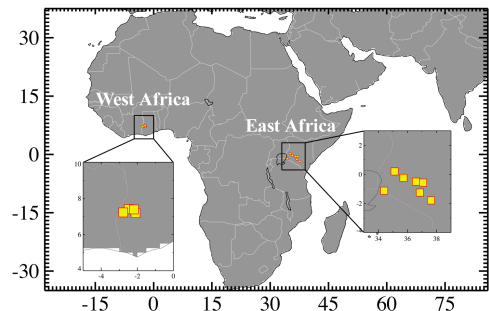

- **CHIRPS**: Climate Hazards Group InfraRed Precipitation with Station

Number of stations/grid used in GPCC
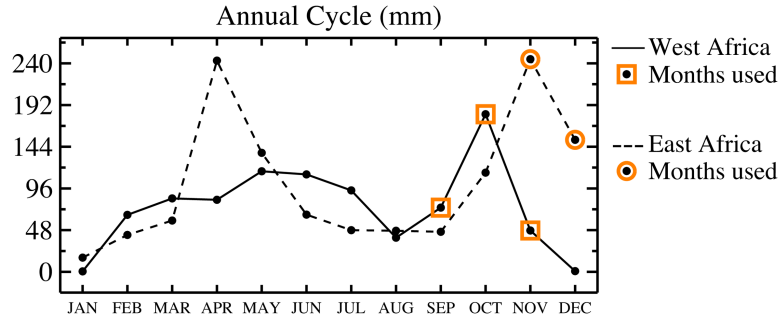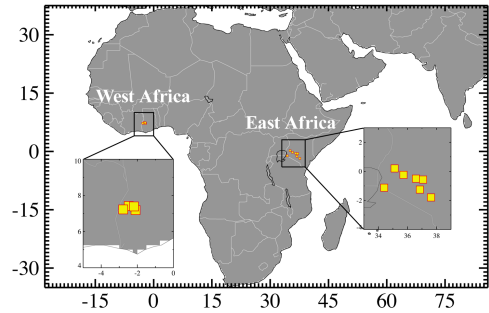

Number of stations per grid
1 2 3 4 6 8 10

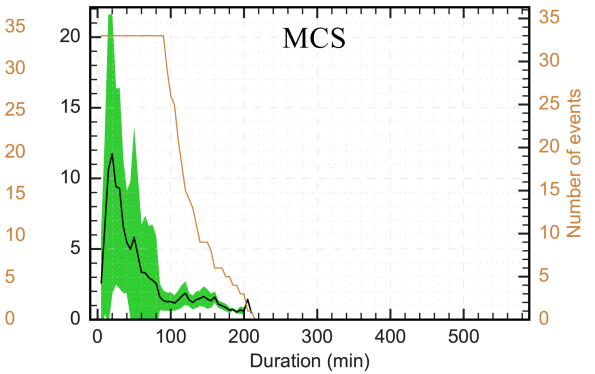# Classifying rainfall events based on duration & intensity
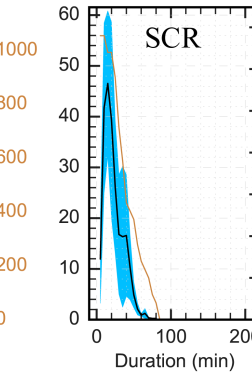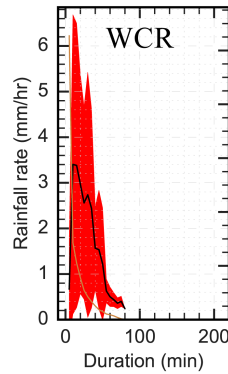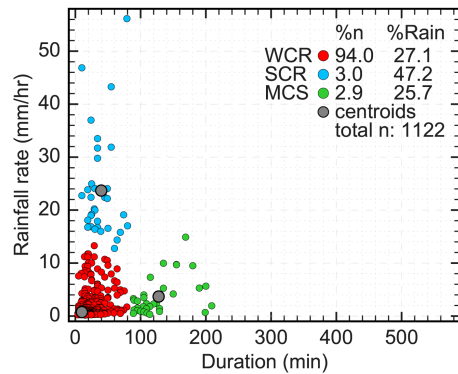

Three rainfall classes:

- **Weak Convective Rainfall (WCR)**
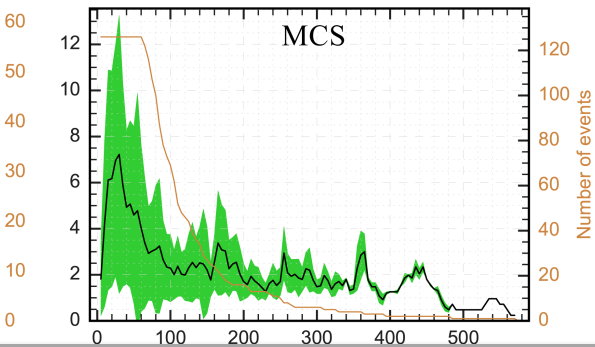- **Strong Convective Rainfall (SCR)**
- **Mesoscale Convective System (MCS)**

Characteristics of three rainfall types

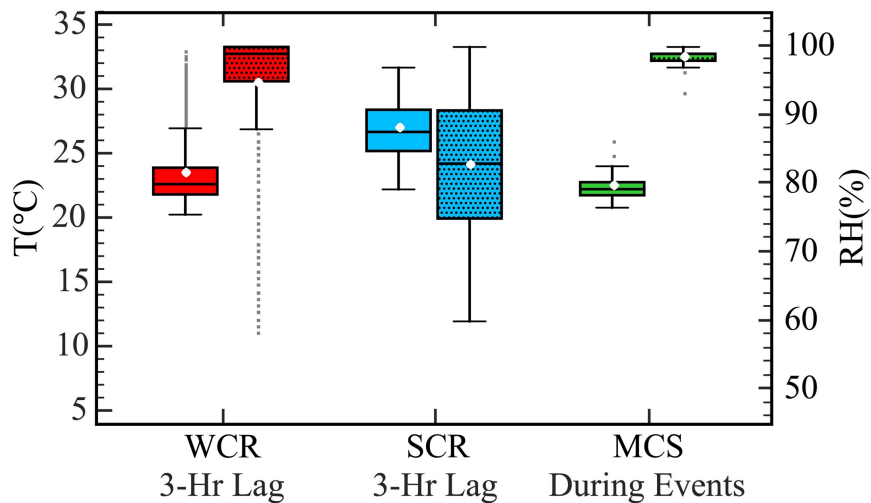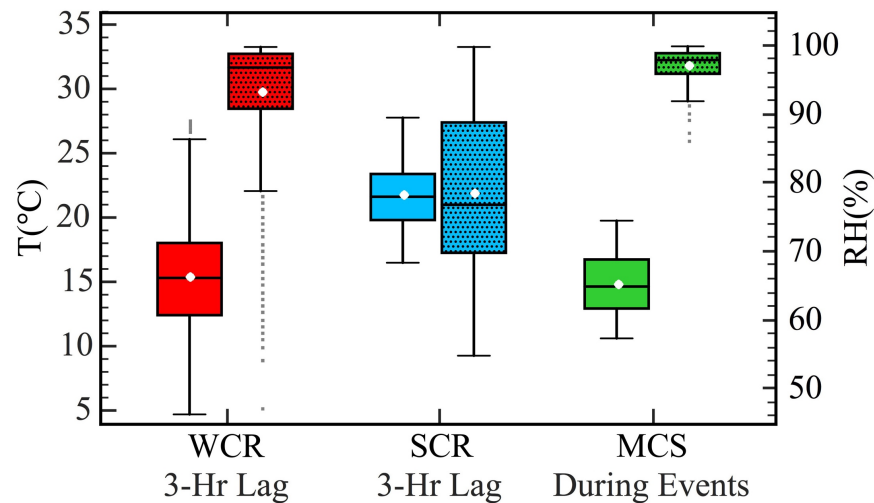# Rainfall rate & duration of all rainy events
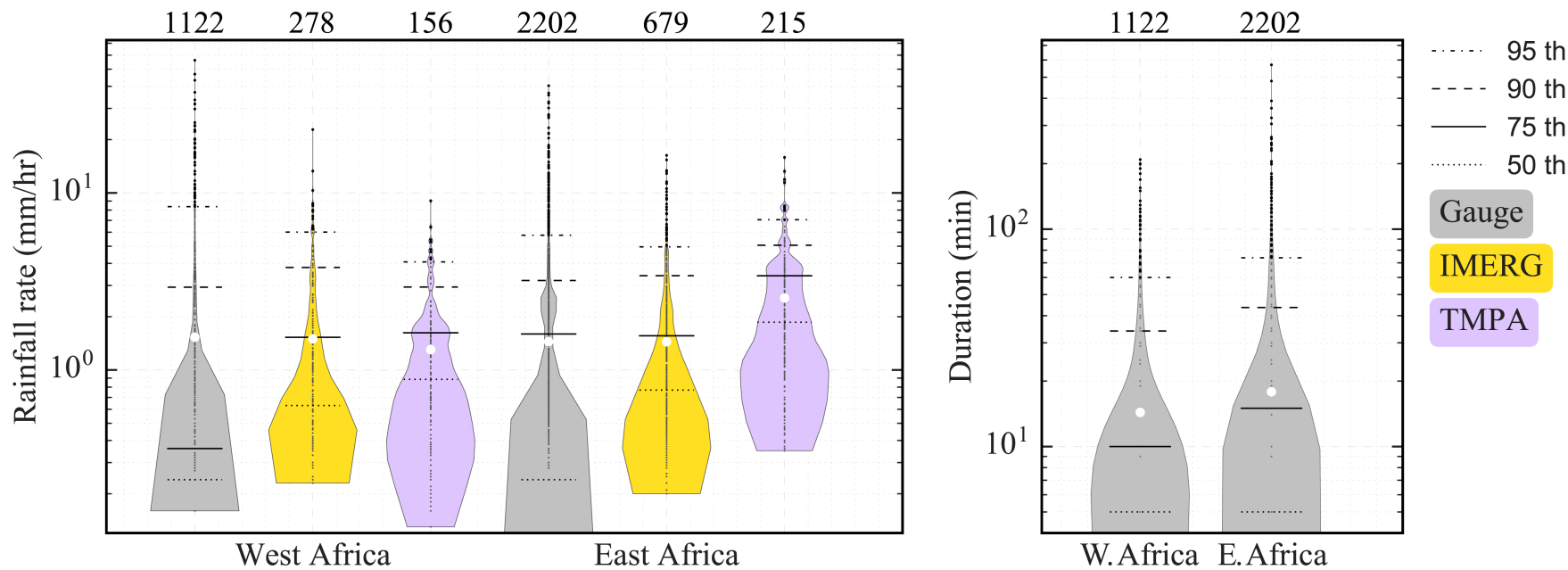
- West vs. East Africa: Comparable means, but different percentiles
- IMERG offers advantages over TMPA in capturing the PDF of rainfall intensity for both regions

- Relatively longer duration in East Africa
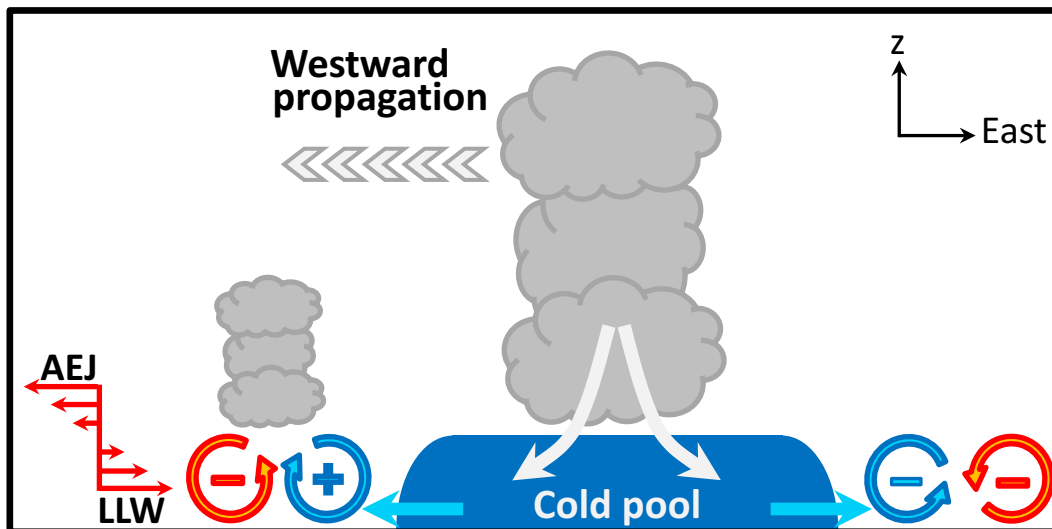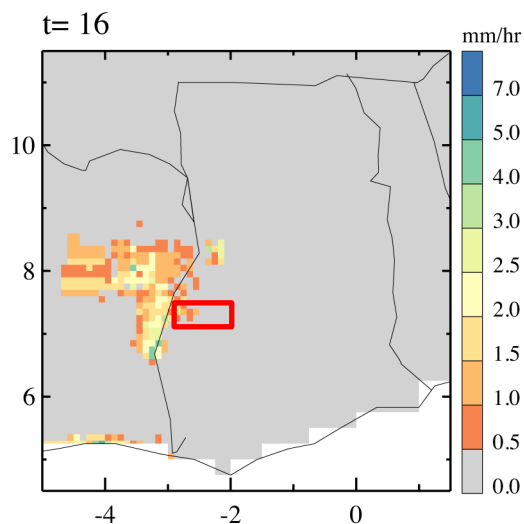
Surface conditions for different rainfall types

West Africa

East Africa

IMERG-Final Run

Westward propagating MCS in West Africa
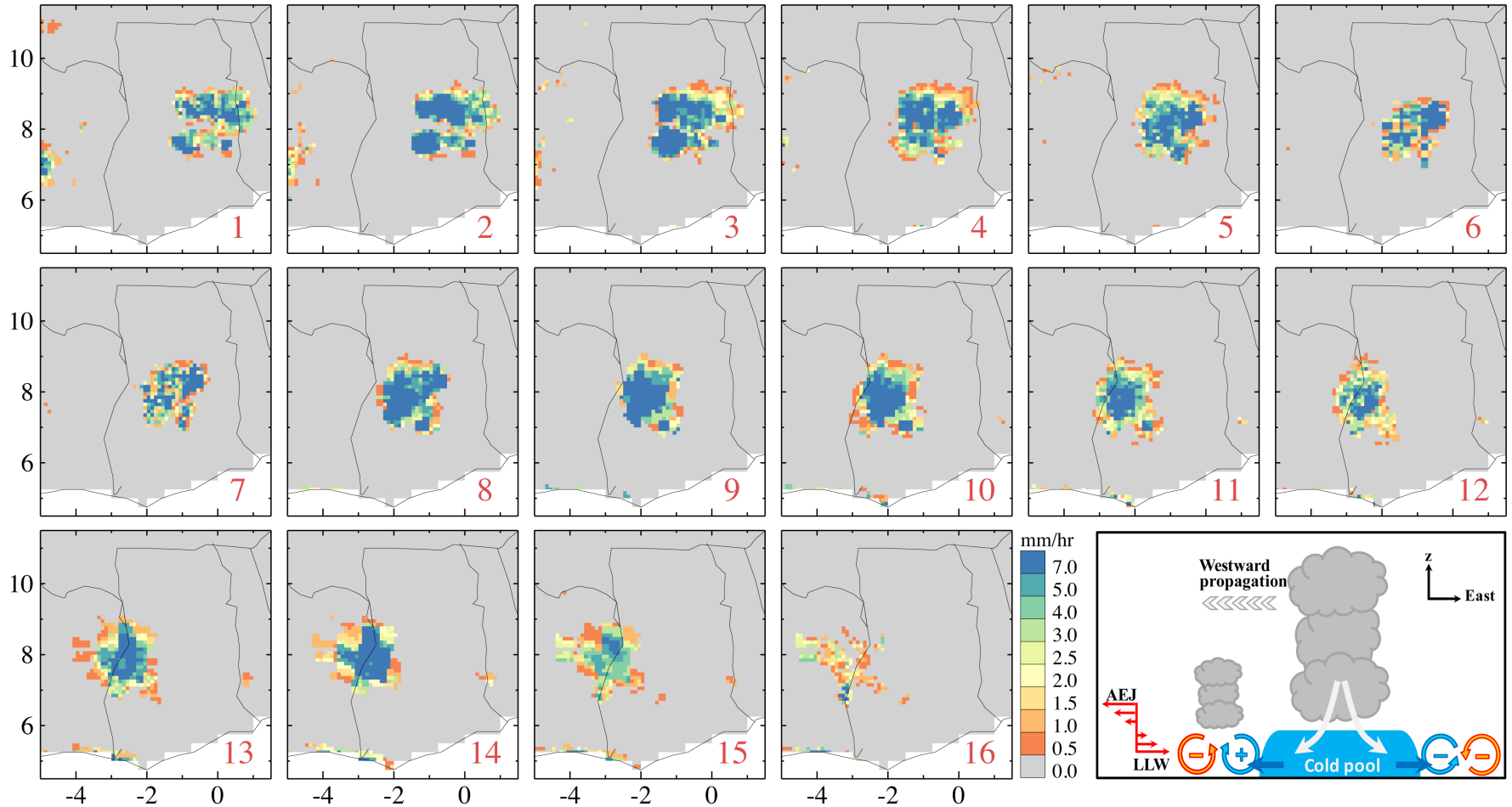
Location of stations & rainfall climatology

Number of GPCC stations used in 2015

TAHMO stations

Stations Set 1
Stations Set 2
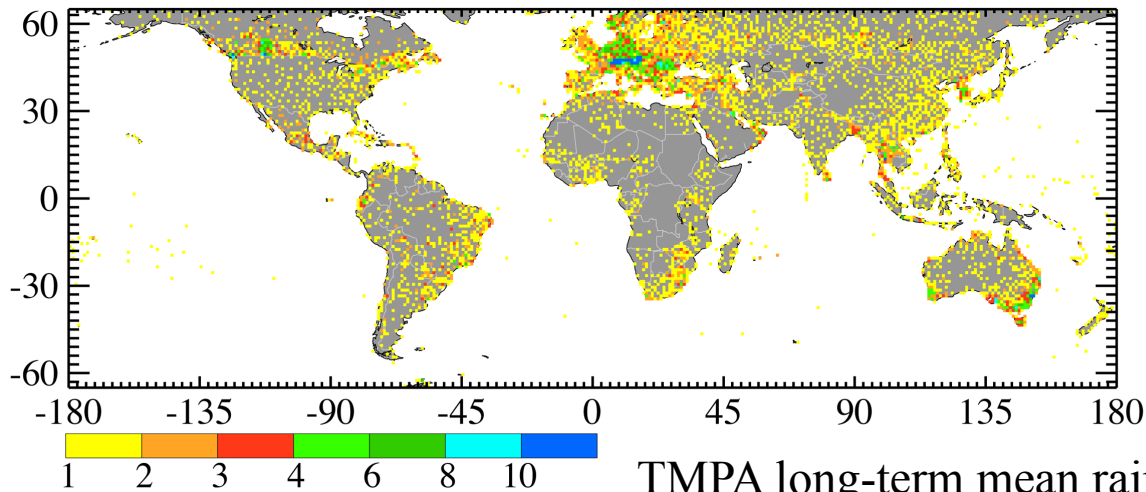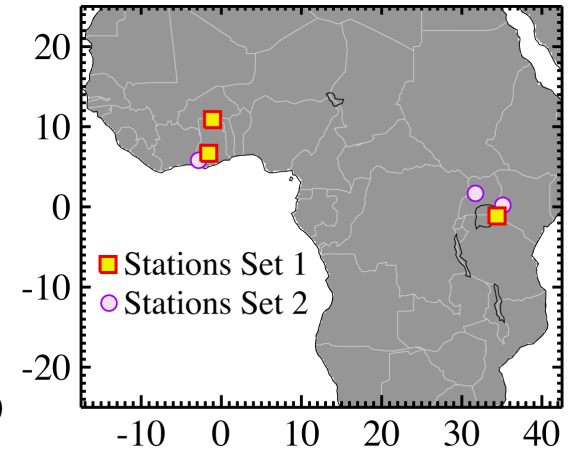
TMPA long-term mean rainfall (1998-2015)

Jan   Apr   Jul   Oct

0   25   50   100   150   200   mm
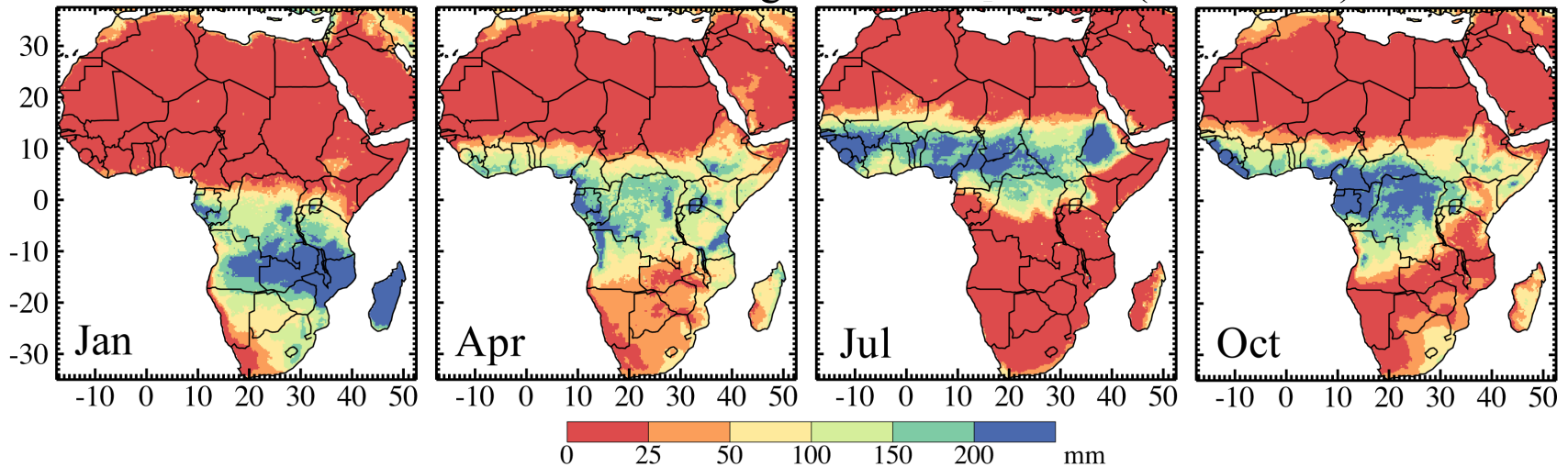
Station 1: Lela Primary School, Kenya

Annual cycle (2015)

Diurnal cycle

Gauge — IMERG — TMPA — GPCC — CHIRPS — TMPA_LTM

Station 2: Navrongo, Ghana

Annual cycle (2015)
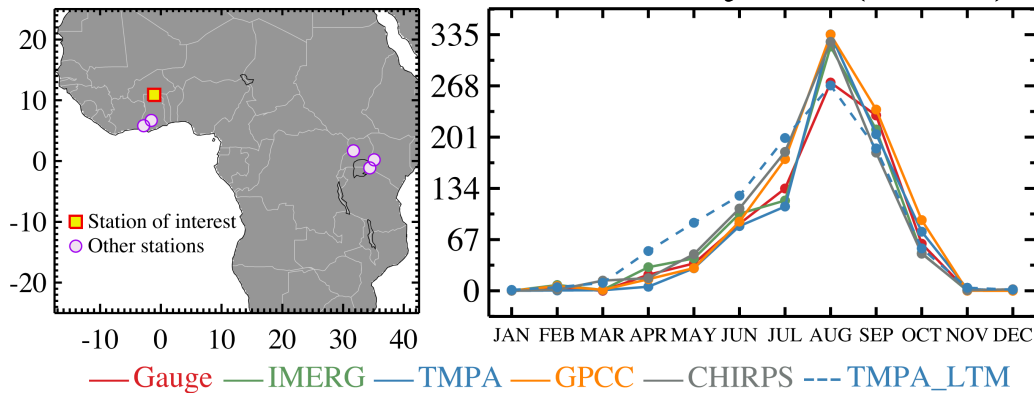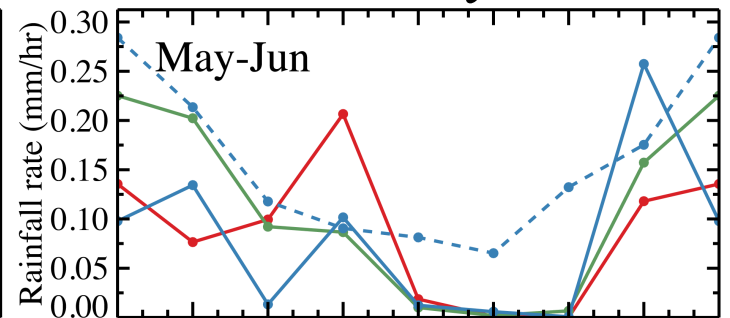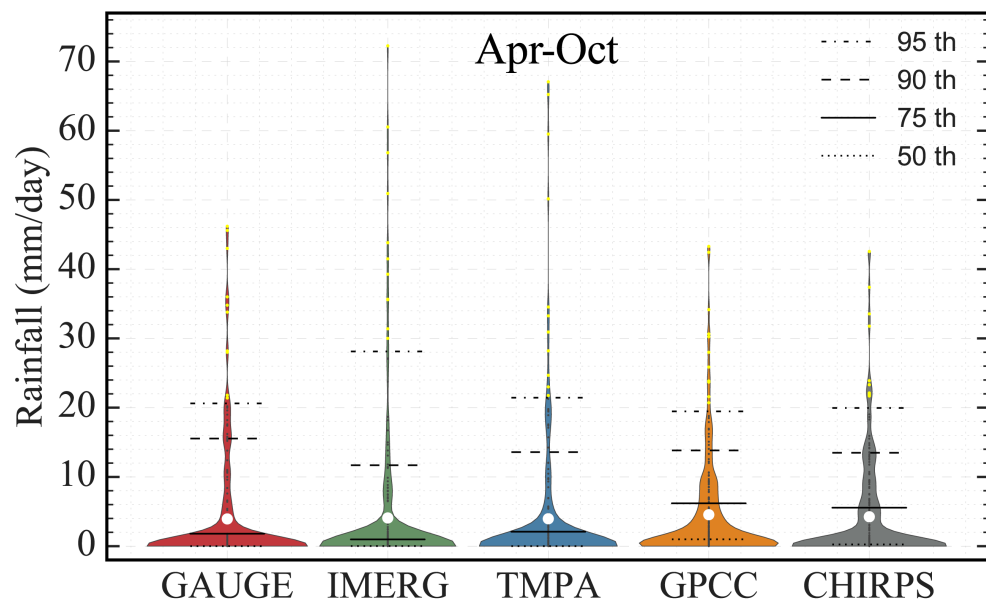
Diurnal cycle

Station 3: Kumasi, Ghana

Annual cycle (2015)

Diurnal cycle

Legend: Gauge — IMERG — TMPA — GPCC — CHIRPS — TMPA_LTM

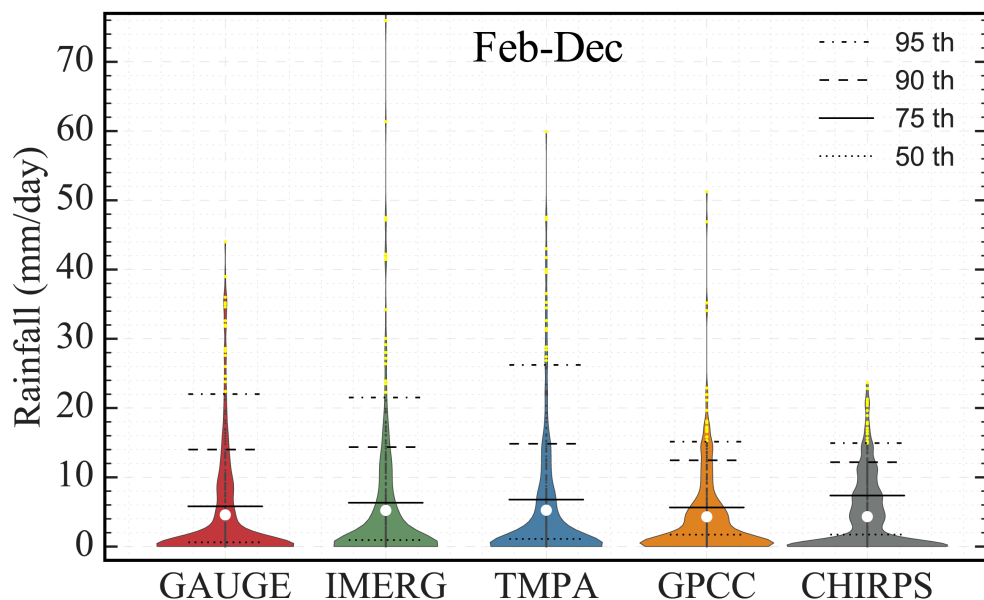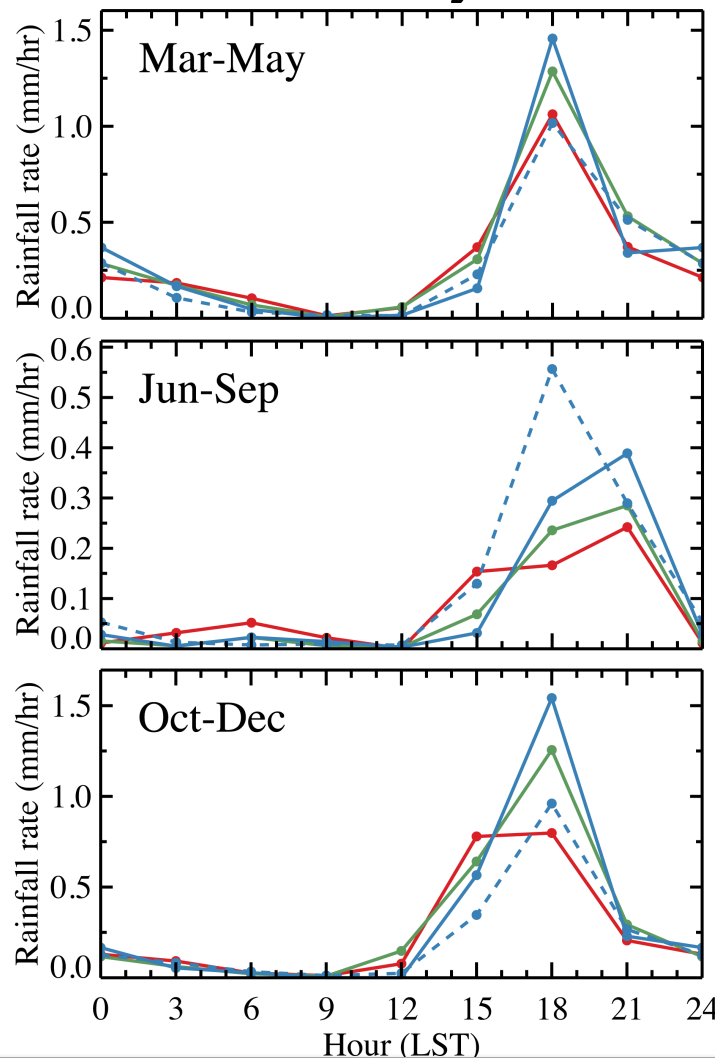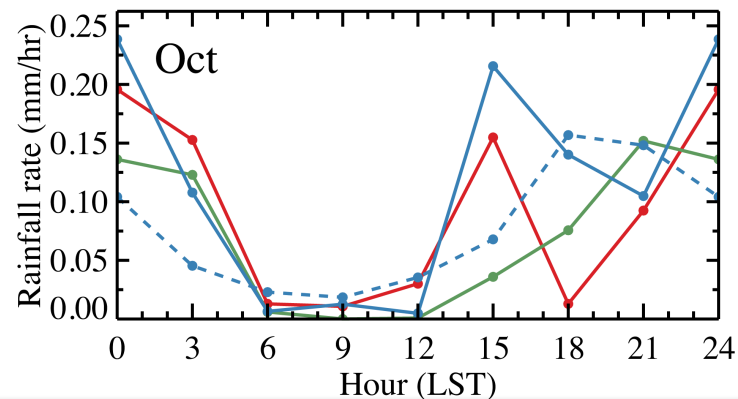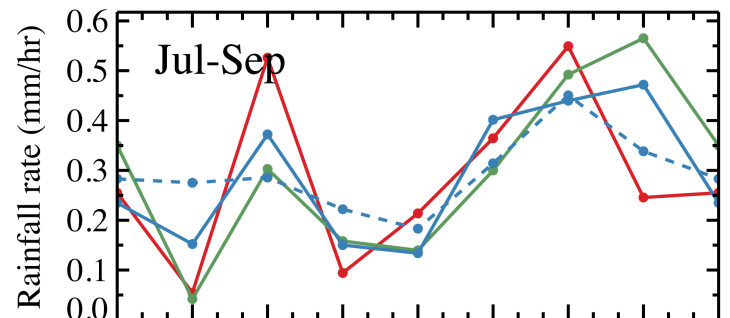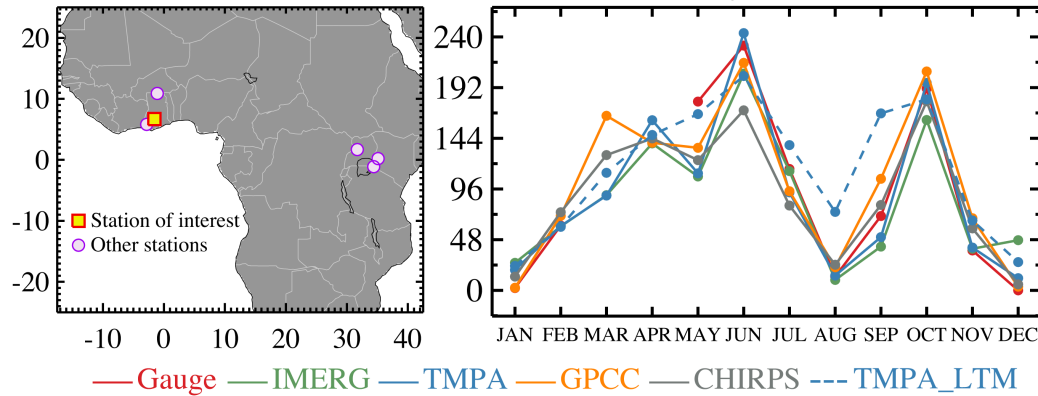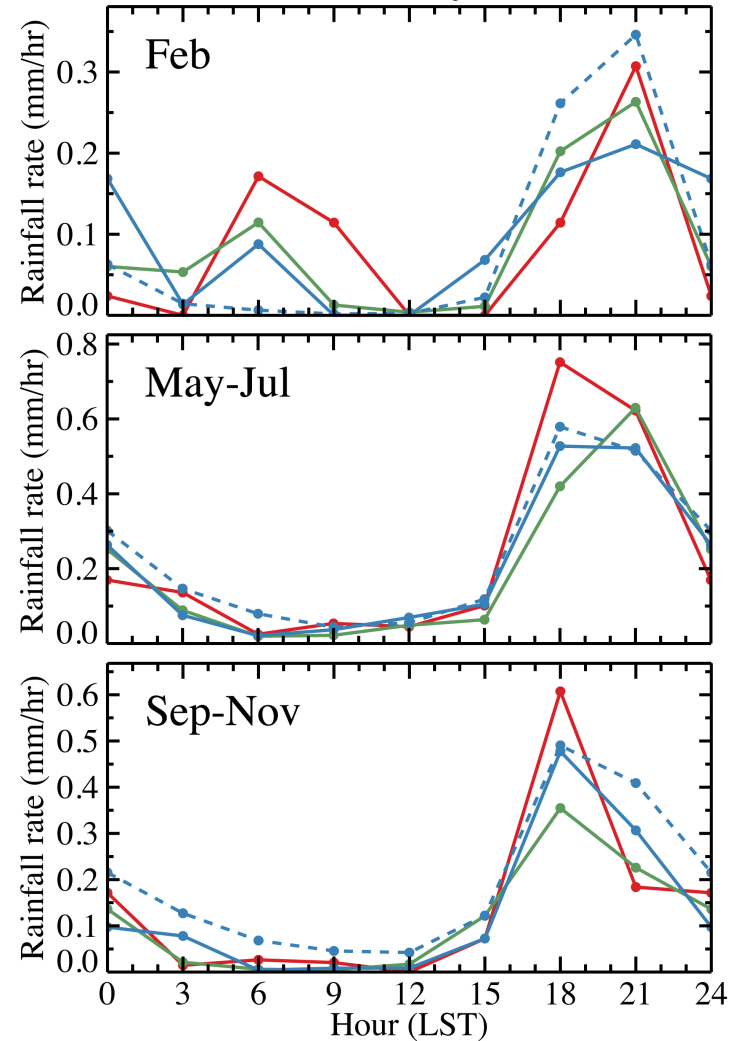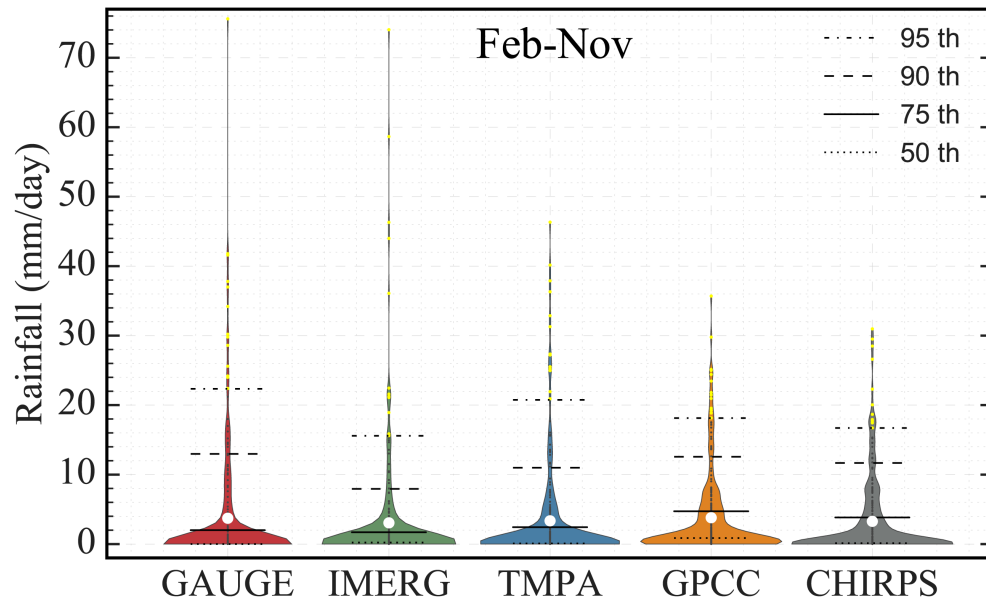# Diurnal cycle for additional stations
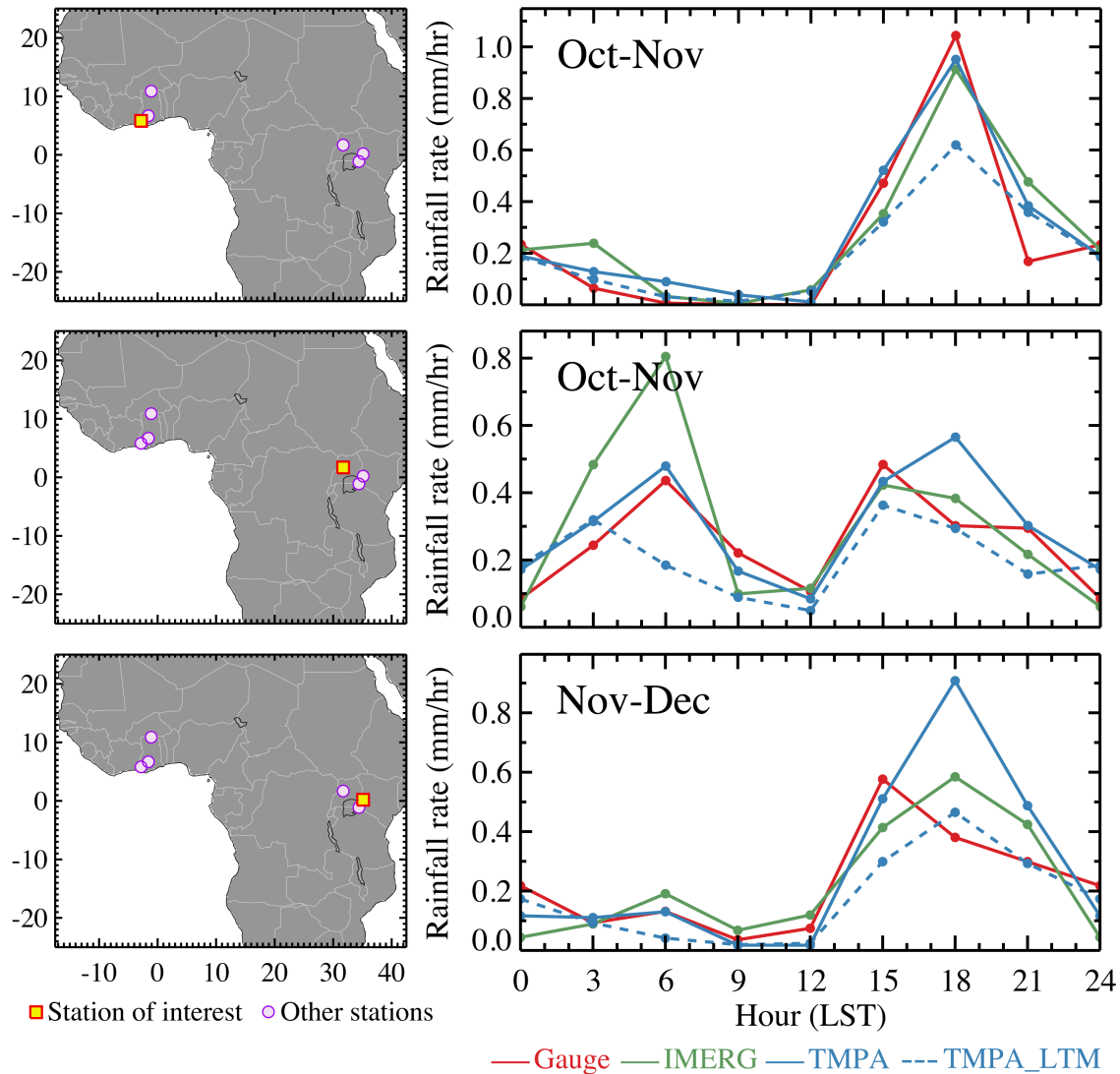
Evaluation measures: IMERG vs TMPA

A: hit
B: false alarm
C: miss
D: correct rejection

Prob. of Detection:
$$\frac{A}{A+C}$$

False Alarm Ratio:
$$\frac{B}{A+B}$$

Fractions Brier Score:
$$\frac{A+B}{A+C}$$

Critical Success Index:
$$\frac{A}{A+B+C}$$

Heidke Skill Score:
$$\frac{2(AD-BC)}{(A+C)(C+D)+(A+B)(B+D)}$$

Perfect value: ① or ⓪

Conclusions

- Three classes of rainfall identified using in-situ observations:
  - WCR: Duration < 40 minutes and Intensity < 10 mm/hr
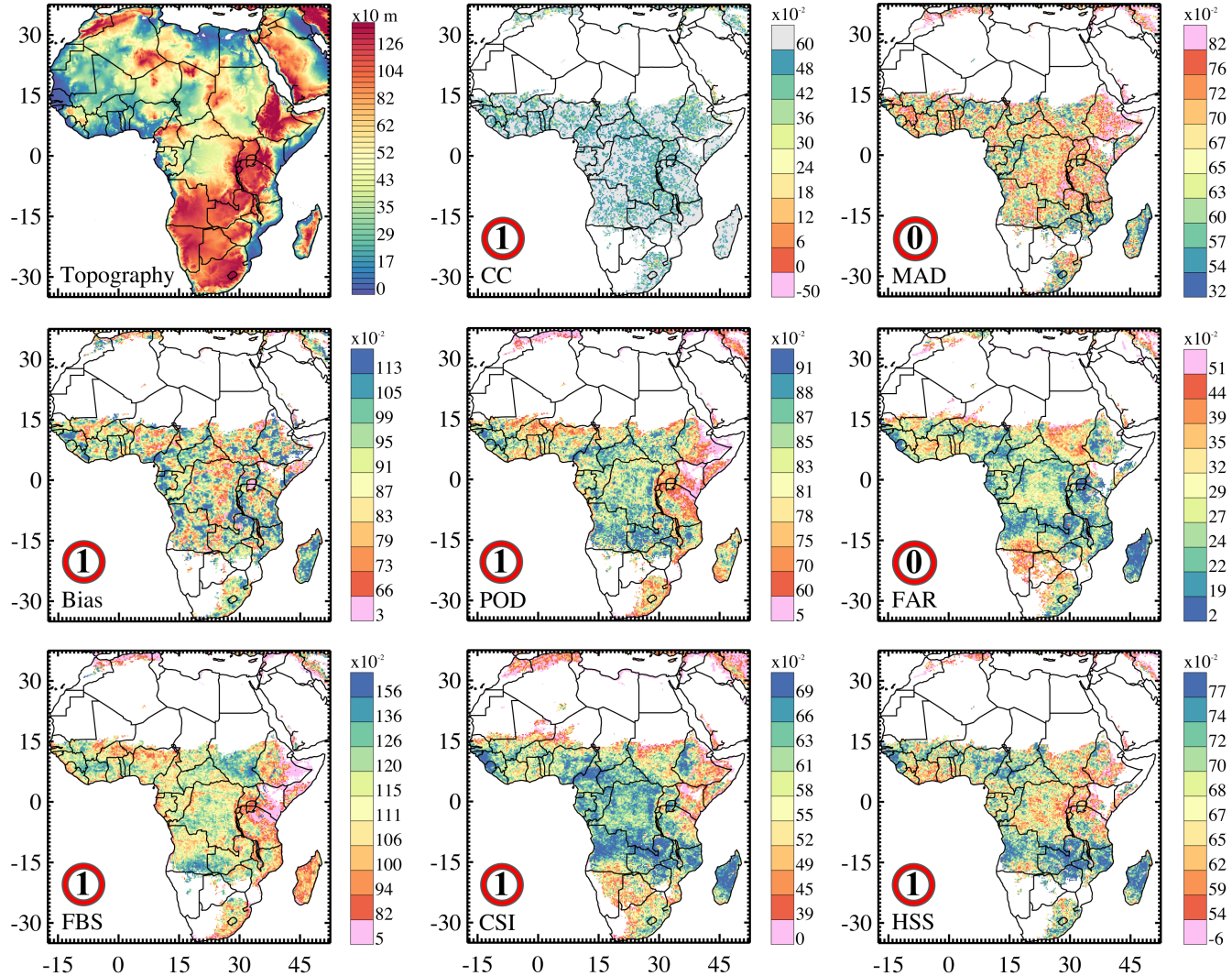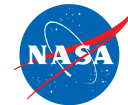 - SCR: Duration < 80 minutes and Intensity > 10 mm/hr
  - MCS: Duration > 80 minutes and Intensity < 10 mm/hr

- SCR + MCS: 75% of total rainfall from 8% of rain events

- Which data to use: depends on region/season/objective

- IMERG-V04 has some advantages due to its half-hourly resolution, but not a clear victory over TMPA!

Articles:

- Dezfuli, A.K., Ichoku, C.M., Mohr, K. and Huffman, G.J., 2017. Precipitation characteristics in West and East Africa, from satellite and in-situ observations. *Journal of Hydrometeorology*, (2017).

- Dezfuli, A.K., et al., 2017. Validation of IMERG Precipitation in Africa. *Journal of Hydrometeorology*, *18*(10), pp.2817-2825.